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RESEARCH NOTES:

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Technical Evaluation of Photo Speed Enforcement for Freeways

Motivation for the Research

Extreme speeding on urban-area freeways contributes to public opinions that the freeways are unsafe, as well as increased crashes that result in property damage, injury, and fatalities.

For transportation agencies such as the Arizona Department of Transportation (ADOT), this is an area of significant concern that means more crash cleanup, more infrastructure damage, more repairs, more tragedy and loss for all involved, and potential liability exposure. For emergency response agencies it means increased exposure to high speed traffic when responding to crashes. These areas are also critical to the Arizona Department of Public Safety (DPS), which is responsible for enforcing speed limits, and for working with ADOT to promote safe public travel and to reduce the effects of high-speed crashes on urban freeways.

Intelligent Transportation Systems (ITS) now exist to accurately enforce safe <u>municipal</u> speed limits using camera-based technology. These enforcement technologies are generically called "speed cameras" and have been effective on municipal streets and arterials. As of 2005, at least 75 countries rely on such cameras to enforce speed limits, especially on high-risk roads, including Australia, Austria, Canada, Germany, Greece, Italy, the Netherlands, Norway, South Africa, Spain, Switzerland, and Taiwan.

Compared with other countries, municipal police in the U.S. have used speed cameras on a limited basis but their use is expanding. Cameras currently are in use in municipalities in several states, including Arizona, California, Colorado, North Carolina, Ohio, Oregon, and the District of Columbia.

Whereas speed cameras have been proven on municipal streets, it is technically a much more challenging operating environment to attempt to employ these devices on high-volume, high-speed, multi-lane freeways such as the Phoenix metro (metropolitan) area system managed by ADOT and DPS. The technical problems arising from such a deployment are the focus of this research:

<u>Research Question</u>: *Can any current offerings of vendors of photo speed enforcement systems provide a viable technical solution that will accurately measure the Phoenix metro regional freeway speeding problems, given the needs and constraints of ADOT and DPS? Additionally, can a conceptual trial deployment and accompanying field test plan be developed to demonstrate the technical aspects of potential systems, should it be desired to conduct one in the future?*

It is important to note this research question is limited to the technical aspects of a photo enforcement system. Whereas a violation management system would also need to be studied in detail to fully examine the viability of photo speed enforcement, these aspects are beyond the scope of this report.

Current State of Technology

The first automatic systems to be widely deployed in the United States were red-light running systems. These programs generally proved successful, which led to the use of speed cameras by some U.S. municipalities. The international success of speed cameras has driven the technology. For example, by 2004, the United Kingdom had successfully deployed 6,000 photo speed cameras, and the number continues to grow.

Photo speed enforcement systems use three subsystems: *Vehicle Speed Subsystem*, *Vehicle/Driver Photo Subsystem*, and *Speeding Violation Subsystem*. The *Vehicle Speed Subsystem* typically relies on a radar or laser-based LIDAR sensor to determine the speed of a vehicle, or, it uses an in-pavement sensor. When a vehicle is speeding, this triggers the *Vehicle/Driver Photo Subsystem*, which takes two photos, one of the driver and one of the rear license plate. This requires two cameras, whereas only one camera is needed if (a) the vehicle has a front license plate or (b) the enabling legislation does not require that the driver's picture be recorded. A data record is formed with the speed information coupled with the photos of the driver and license plate for each violation.

The last subsystem, *Speeding Violation Subsystem*, is not part of this research. Its functions are to use the records created by the first two subsystems to identify the driver of the speeding vehicle, issue that person a speeding violation, and prosecute the person if guilt is not admitted.

The speed cameras can be mounted overhead in gantries or at the side of the road (side-fire). Side-fire cameras have limitations on the total number of lanes over which they can successfully capture data. Overhead mounted cameras eliminate this problem because each camera captures a single lane at a relatively close distance to traffic, but this requires more cameras than do side-fire applications.

In addition to fixed locations, photo radar cameras can be mounted in mobile devices. This technology takes two basic forms: (a) moving a camera/sensor from fixed location to fixed location and (b) mounting a camera/sensor in a van or tethered to a vehicle. The concept behind moving the camera/sensor between various fixed locations is to spread driver behavior changes over a larger area, without requiring complete systems at each fixed location. The concept behind mounting a camera/sensor in a van is somewhat similar to a typical law enforcement officer using a radar gun in his/her patrol vehicle to issue speeding citations.

The ability to "automatically" record violations in the mobile photo enforcement van and later issue citations can be said to increase the efficiency of such a unit versus a patrol vehicle. It is important to note that that the mobile unit is quite limited in its function, whereas an officer in a radar-equipped patrol vehicle can instantly switch to other safety functions based on observed information or radio calls.

One new concept being tested at some international sites uses "point-to-point" tracking technology. This technology identifies a vehicle at two different locations along a roadway, which are a known distance apart, and the travel time is used to determine its average speed. This technology substitutes a vehicle recognition system for the radar/LIDAR/in-pavement speed sensors. All vehicle license plate numbers are digitally read and recorded when they pass the first instrumented point and as each vehicle passes the second point it is digitally read and recorded again. License plate identification software is used to match the license plates of a vehicle passing both points. If no match is obtained or if a vehicle is not speeding, the data is automatically erased. The benefit of this system is that it avoids the "slow-down/speed-up" driver behavior along a roadway that can occur at camera locations known to drivers. This technology show great promise for freeway applications.

Ideal System Characteristics

The research project's Technical Advisory Committee (TAC) developed the following list of twelve ideal characteristics for a Photo Speed Enforcement system to be effective on the Phoenix metropolitan area freeways. Many complex interactions can occur between a system and the other activities and goals of ADOT and DPS. The TAC witnessed presentations and/or demonstrations by six vendors and solicited their input based on their knowledge and experience.

1. Mobile deployment options to aid in DPS speeding “sweep” operations.
2. Easily relocatable from one site on a freeway to another.
3. Acceptable light flash intensity.
4. Color photography is desirable to enhance driver/license plate recognition.
5. Identify (ID) both driver and rear license plate.
6. Vendor’s compensation is not tied to revenue.
7. System costs are definable by vendor.
8. Download data in electronic format without entering freeway.
9. No technical bias in identifying violations.
10. No sensors placed in pavements that require lane closures for maintenance.
11. Maintain federal roadside crash safety standards for all devices.
12. System can cover five lanes of freeway traffic in one direction.

Detailed information was obtained from six vendors (ACS, Peek Traffic Corporation, American Traffic Solutions, LaserCraft, Traffipax and Redflex) regarding their current technologies in photo speed enforcement. Most vendors can meet a majority of the twelve ideal characteristics, but no vendor can meet all of them at this time.

Acceptance of Photo Speed Enforcement Systems

Thirteen agencies were interviewed via email and phone that have used or are currently using a photo speed enforcement system. Most of the users report strong public support of their enforcement system, with only two out of thirteen stating that there was an even split in public support. Seven of these organizations were either currently implementing or had implemented the enforcement system on major highways. Three of these jurisdictions, one in Madrid, Spain, one in New South Wales, Australia, and the last in the City of Zurich, Switzerland, are implementing their automated systems on highways with three or more lanes of traffic in each direction. But while these conditions are similar to the Phoenix metro freeways, they lack some specific features that complicate the technical aspects of deploying a vendor’s system. Four systems are mobile systems and have or are using their systems on multiple lanes of traffic, but these require manual setup and/or manual monitoring. They typically target only one specific lane using manual efforts.

The link between speed and safety is well established by research over the last several decades. What is less well documented is the relationship between photo speed enforcement and safety. The effectiveness of speed cameras in reducing speeds, and the number of road crashes and casualties, is widely debated and depends on several factors: (a) the causes of road crashes and the extent to which speed in excess of the limit is a factor, (b) the potential for offenders to be identified, and (c) public attitudes to speed cameras.

It is not straightforward to draw conclusions on the impact of speed camera use from aggregate crash statistics. Trends can arise from many factors (e.g., other road safety measures) in addition to speed enforcement. However, research about deployed systems does generally support a link between improved safety and use of the systems. Specific supporting research is cited in this report from the United Kingdom, Hong Kong, Queensland, Australia, British Columbia, Canada, and Washington D.C.

Public opinion regarding the use of photo speed enforcement systems varies from country to country and from city to city. Generalizations cannot easily be made. Differences in the cultures of countries may have an impact. Opinions supporting the systems center on

(a) driver behavior changes that decrease collisions and improve road safety and (b) freeing law enforcement officers to focus on other tasks. Opinions opposing the systems include (a) accusations of fund raising, (b) placing an over-emphasis on speed, (c) privacy issues, and (d) concerns that slow-down/speed-up behavior occurs which negates real speed reduction. Specific opinion surveys are cited from the United Kingdom, Canada, Australia, and Washington D.C.

The City of Scottsdale, Arizona, began operating speed cameras in its municipality approximately seven years ago. The City has found the program to be successful based on its goal of improving safety, as measured through various statistics dealing with reductions in the number of violations, number of collisions, and number of fatalities. It has also sampled public opinion on approximately an annual basis about its combined red light and speed camera program and has found that a majority of its citizens support the combined program and its expansion. A limited survey of opinion has been conducted on just the speed cameras alone, without the red light cameras, and the majority of this sample also has viewed them favorably.

This research also considers countermeasures, which are devices used to counteract enforcement programs. No independent research was found that documents the effectiveness of countermeasure devices. Most system vendors are familiar with the common types of countermeasures and in general do not regard them as particularly effective. Laws exist in many states, including Arizona, that prohibit some of these countermeasures.

Conceptual Design of A Field Trial and Test Plan

Based on the system characteristics identified as ideal for the Phoenix metro area freeways, no existing system was found that has been deployed long enough to serve as a model for the development of a field trial. Therefore, a conceptual Model RFP was developed, whose purpose is to raise several likely topics that should be considered. It can serve as a guide to prepare an actual RFP, should it be desired to do so at some point in the future. It includes a Conceptual Field Plan to gather the data needed to evaluate the performance and suitability of a vendor's system for meeting ADOT's and DPS's needs.

Conclusions

Advancements are continuously being made in photo enforcement systems and it is logical to predict that the ideal technical attributes identified in this research could be met by one or more vendors in the future. One new technology that shows promise is point-to-point tracking, which determines average speed between two points on a roadway.

At this time, however, gaps exist between the current vendor systems and the ideal system characteristics needed for the Phoenix metro area freeways. Additionally, this research focused exclusively on the technical aspects of a photo enforcement system. Whereas the violation processing and management elements would also need to be studied in detail to fully examine the viability of a photo enforcement system, these aspects are beyond the scope of this project. Until the enforcement management process issues are addressed, no recommendation can be made from this study regarding the usefulness of proceeding with a field trial of photo enforcement for freeways.

The full report: *Technical Evaluation of Photo Speed Enforcement* by Craig A. Roberts, Ph.D., P.E., and Jamie Brown-Esplain, Northern Arizona University (Arizona Department of Transportation, report number AZ-05-596, published October 2005) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.